Amendments to the Specification

Please replace the paragraph beginning on page 4, lines 5-15, with the following amended paragraph:

The invention is a radio frequency (RF) driven plasma ion source with an external RF antenna, i.e. the RF antenna is positioned outside the plasma generating chamber rather than inside. The RF antenna is typically formed of a small diameter metal tube coated with an insulator. ~~A flange is~~ Two flanges are used to mount the external RF antenna assembly to the ion source. The RF antenna tubing is wound around ~~the flange~~ an open inner cylinder to form a coil. The external RF antenna assembly ~~flange~~ is formed of a material, e.g. quartz, ~~that~~ which is essentially transparent to the RF waves. The external RF antenna assembly ~~flange~~ is attached to and forms a part of the plasma source chamber so that the RF waves emitted by the RF antenna enter into the inside of the plasma chamber and ionize a gas contained therein. The plasma ion source is typically a multi-cusp ion source. A particular embodiment of the ion source with external antenna includes a sputtering converter for production of negative ions. A LaB_6 converter can be used for boron ions.

Please replace the paragraph beginning on page 4, lines 20-21, with the following amended paragraph:

Figures 6A, B are end and side views of ~~a flange~~ an external RF antenna assembly for mounting an external RF antenna to a plasma ion source according to the invention.

Please replace the paragraphs beginning on page 5, lines 17-22 through page 6, lines 1-17, with the following amended paragraphs:

A plasma ion source 10, which incorporates an external RF antenna 12, is illustrated in Figure 1. Plasma ion source 10 is preferably a multi-cusp ion source having a plurality of permanent magnets 14 arranged with alternating polarity around a source chamber 16, which is typically cylindrical in shape. External antenna 12 is wound around external RF antenna assembly ~~flange~~ 18 and electrically connected to a RF power source 20 (which includes suitable matching circuits), typically 2MHz or 13.5 MHz. ~~Flange~~ The external RF antenna assembly 18 is made of a material such as quartz that easily transmits the RF waves. ~~Flange~~ The external RF antenna assembly 18 is mounted between two plasma chamber body sections 22a, 22b, typically with O-rings 24 providing a seal. Chamber body sections 22a, 22b are typically made of metal or other material that does not transmit RF waves therethrough. The chamber body sections 22a, 22b and the external RF antenna assembly ~~flange~~ 18 together define the plasma chamber 16 therein. Gas inlet 26 in (or near) one end of chamber 16 allows the gas to be ionized to be input into source chamber 16.

The opposed end of the ion source chamber 16 is closed by an extractor 28 which contains a central aperture 30 through which the ion beam can pass or be extracted by applying suitable voltages from an associated extraction power supply 32. Extractor 28 is shown as a simple single electrode but may be a more complex system, e.g. formed of a plasma electrode and an extraction electrode, as is known in the art. Extractor 28 is also shown with a single extraction aperture 30 but may contain a plurality of apertures for multiple beamlet extraction.

In operation, the RF driven plasma ion source 10 produces ions in source chamber 16 by inductively coupling RF power from external RF antenna 12 through ~~flange~~ the external RF

antenna assembly 18 into the gas in chamber 16. The ions are extracted along beam axis 34 through extractor 28. The ions can be positive or negative; electrons can also be extracted.

Please replace the paragraphs beginning on page 6, lines 21-23 through page 7, lines 1-10, with the following amended paragraphs:

Plasma ion source 40, shown in Figure 2, is similar to plasma ion source 10 of Figure 1, except that ~~flange~~ the external RF antenna assembly 18 with external antenna 12 is mounted to one end of a single plasma chamber body section 22 instead of between two body sections 22a, 22b. The chamber body section 22 and the external RF antenna assembly ~~flange~~ 18 together define the plasma chamber 16 therein. The extractor 28 is mounted directly to the external RF antenna assembly ~~flange~~ 18 in place of the second body section so that external RF antenna assembly ~~flange~~ 18 is mounted between body section 22 and extractor 30.

Plasma ion source 42, shown in Figure 3, is similar to plasma ion source 40 of Figure 2, with ~~flange~~ the external RF antenna assembly 18 with external antenna 12 mounted to the end of a single plasma chamber body section 22. However, ion source 42 is much more compact than ion source 40 since the chamber body section 22 is much shorter, i.e. chamber 16 is much shorter. In Figure 2, the length of chamber body section 22 is much longer than the length of ~~flange~~ the external RF antenna assembly 12 while in Figure 3 it is much shorter. Such a short ion source is not easy to achieve with an internal antenna.

Please replace the paragraph beginning on page 7, lines 16-22 through page 8, lines 1-9, with the following amended paragraph:

Plasma ion source 50, shown in Figure 5, is similar to plasma ion source 42 of Figure 3, but is designed for negative ion production. An external antenna arrangement is ideal for surface

conversion negative ion production. A negative ion converter 52 is placed in the chamber 16. Antenna 12 is located between the converter 52 and aperture 30 of extractor 28. ~~A dense~~ Dense plasma can be produced in front of the converter surface. The thickness of the plasma layer can be optimized to reduce the negative ion loss due to stripping.

Figures 6A, B illustrate the structure of ~~a flange~~ an external RF antenna assembly 18 of Figures 1-5 for housing and mounting an external antenna to a plasma ion source. ~~Flange~~ The external RF antenna assembly 18 is formed of an open inner cylinder 60 having ~~a~~ an inner diameter D1 and a pair of annular ~~end pieces~~ flanges 62 attached to the ends of cylinder ~~62~~ 60 and extending outward (from inner diameter D1) to a greater outer diameter D2. Spaced around the outer perimeter of the annular flanges ~~pieces~~ 62 are a plurality of support pins 64 extending between the flanges ~~pieces~~ 62 to help maintain structural integrity. The inner cylinder 60 and extending ~~end~~ flanges ~~pieces~~ 62 define a channel 66 in which an RF antenna coil can be wound. The channel 66 has a length T1 and the flange has a total length T2.